Challenge 1: Can audio recordings be used to detect leaks and coughs during mechanical insufflation exsufflation (MI-E) treatment?

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Background: Breas Medical is a global company specialising in improving the care and quality of life of respiratory patients using home mechanical ventilation devices.

One such device is a mechanical insufflation-exsufflation (MI-E) device which helps people with neuromuscular weakness (pwNMW) to cough more effectively. An ineffective cough can lead to a build up of secretions in the respiratory tract. This is a major cause of mortality and morbidity in patients with weak cough, typically those with neuromuscular disease due to weak inspiratory of expiratory muscles or bulbar impairment.

An effective cough has three components: 1) A deep inspiration; 2) Rapid closure of the glottis for ~0.2 seconds, coupled with contraction of abdominal and intercostal muscles to generate intrapleural pressures of >190 cmH20; and 3) An explosive decompression that generates transient cough peak flows (CPF). If any of these components are missing or impaired, a cough can be ineffective. When the CPF is < 180L/min, a MI-E device is typically prescribed. The MI-E device provides a deep breath in (insufflation) followed by a rapid switch to negative pressure (exsufflation). The simulated changes in flow from the device mimic what occurs naturally during a cough and thereby assist cough strength, avoiding build-up of secretions in the lungs.

The problem*:* For the MI-E device to be effective, there needs to be minimal leak. Leak is a problem because the inspiratory volume cannot be achieved, or it can only be achieved over a prolonged period. This can lead to ineffective treatment and discomfort for the person using the device. One way to evaluate leak is via the pressure profile. However, not all devices can provide both the pressure and flow signals, which can complicate evaluation for some clinicians.

The audibility of a patient's cough can be used to determine its effectiveness. The patient is asked to cough and depending on the strength and sound of the cough, it is deemed effective or ineffective. Leak is often audible and therefore an analysis of the sound generated may be one option to evaluate efficacy.

The Challenge: We hope to answer the following question: can a machine identify suboptimal MI-E treatments through analysis of an audio recording by detecting the presence of leak or the lack of a patient cough? This will help us to understand options for supporting users of our devices outside of medical settings.

In particular, we hope that study group participants will develop an algorithm using labelled audio recordings of MI-E treatment sessions, to identify: 1) Whether or not the

patient's mask is leaking, and 2) Whether or not the patient has coughed during the treatment.

We are also open to the participants exploring other methods and approaches using the data available.

Data available: Breas will make available a dataset of ~ 50 treatment audio recordings of MI-E which will be labelled to indicate the presence of cough and leak. The recordings are of real patients being treated with a range of MI-E devices. We can also make available examples of flow traces, not linked to the audio recordings, which could help inform the model. We hope to bring the device to the study group for participants to gain a better understanding of how it functions and the problem presented.

Relevant expertise*:* This challenge will be particularly relevant to those with expertise in data science/ statistical modelling and machine learning, as well as experience or interest in working with audio data.

References

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